NOTES ON THE PEAR-SLUG.*

Eriocampoides limacina Retz.

By R. L. Webster.

Recent Injury. Nearly every year cherry and plum trees in Iowa suffer much injury by the common pear-slug. While the control of this insect has never been considered a difficult problem, yet it happens frequently that foliage is greatly damaged before one is aware that any slugs are present.

Serious damage is sometimes caused to cherry trees. Young cherry trees in the town of Ames have been killed as a result of defoliation following the injury by the slugs.

Appearance of the Injury. The slugs feed on the upper surface of the leaves, eating the parencyhma and leaving only the veins and the lower epidermis. Leaves thus eaten, dry, turn brown, curl up and fall from the tree. Frequently infested trees are left entirely bare of foliage in midsummer.

The Insect's Appearance. The insects in question are dark, olive colored slugs, with a slimy covering. The fore part of the body, just back of the head, is broad, but it tapers back of this. Where the slugs are common a peculiar sour odor may be noticed.

The slugs molt five times, and when mature they are about 2-5 of an inch long. After the last molt the slug has a clean and dry skin, quite free of slime, and orange in color. These orange slugs go to the ground and form small earthen cells in which to pupate. When the adult sawflies emerge they deposit eggs in the tissue of plants on which the young slugs are to feed.

PAST HISTORY AND DISTRIBUTION.

This insect has long been known in Europe. As far back as 1740 Reaumur gave an account of the pest and its injury. The first American account was written by Prof. Wm. D. Peck, of Harvard, and published in 1799.

Professor Peck wrote an essay on the insect, entitled the "Natural History of the Slug-Worm," which won for him a gold medal and a prize of fifty dollars, given by the Massachu-

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setts Society for Promoting Agriculture. The essay was printed by the Society but it has now become very scarce. Harris, writing in 1841, said that the pamphlet was then "out of print and rarely to be met with." It was the good fortune of the writer to find this paper of fourteen pages in the Boston Public Library last winter. That so much concerning the habits of this insect had been determined at such an early date in the history of American economic entomology, is indeed surprising. In fact, almost all of the information concerning the insect in America dates back to the account of Peck.

The insect is widely distributed, having been recorded in Europe, North America, Australia, New Zealand and South Africa.

LIFE HISTORY.

GENERATIONS. There are in central Iowa two quite distinct generations of the insect. In the fall a very few slugs were found, lagging way behind the others, but these are probably only delayed individuals from the second generation, rather than a partial third generation.

About Ames the eggs and adults were found in late May and early June and larvae appeared in the fore part of June. By July 5 the first brood slugs were practically all gone. The adults from this brood of slugs appear about the middle of July and their eggs hatch late in the month. The slugs begin to mature a little before the middle of August and by September 1st they are practically all gone.

A part of the first brood larvae do not complete their transformations at once after entering the soil but remain as larvae until the next spring, making but one generation a year for a part of the slugs. This was noticed by Professor Peck and later by Marlatt. It seems to be a provision for the preservation of the species. Should the second generation be wiped out by natural enemies, the slugs that are held over would still be left to propagate the species the next season.

THE EGG. The eggs are deposited in the leaf tissue of the various food plants—placed just beneath the upper epidermis and thrust through the leaf from below.

In the insectary eggs hatched in 10 to 14 days in the spring; average, 12.1 days; in summer in 7 to 13 days, average, 10.5 days.

Parthenogensis probably occurs with this insect, but this has not been satisfactorily proved. Many sawflies were examined, but no males were found. Eggs deposited by virgin females hatched, but all the larvae were weak, and none even reached the second stage.

THE LARVA. The newly hatched slug is about 1.2 mm. long, at first free from slime, but this is secreted in a few hours. The young slugs begin to eat out tiny patches in the epidermis; later they eat through the parenchyma to the lower epidermis, leaving the veins. One slug ate a space of 825.9 square millimeters during its lifetime, 19 days, according to a record kept by Mr. T. M. McCall, insectary assistant at the time.

After each molt, except the last, the larvae eat their cast skin, all of it but the head.

Five molts are probably normal. In 14 cases 5 larvae molted 5 times; 5, 6 times; 3, 7 times, and 1 larva molted 8 times, all under insectary conditions. Sometimes in successive molts the width of the cast head was exactly the same; often there was very little difference.

The average head widths of the stages were: Stage I, .35 mm.; II, .51 mm.; III, .67 mm.; IV, .85 mm.; V, 1.04 mm.; VI, 1.13 mm. The geometrical ratio between the successive head widths was practically .35.

Larvae matured in 13 to 26 days; average 19.4 days. No essential differences were noticed in the two generations of the time required; the same total length was found in either case. The time required for the separate stages was: I, 5 days; II, 3.2 days; III, 3.4 days; IV, 3.2 days; V, 4.7 days (average from both generations). Stage VI usually entered the soil immediately after molting.

Both Peck and Marlatt remarked that heavy rains are said to destroy the slugs. Professor Peck, however, said that he had seen the slugs retreat to the under sides of the leaves in a shower; a fact that we observed several times in the Iowa work. It seems quite likely that the supposed efficiency of heavy rains is really only the disappearance of the slugs to the lower sides of the leaves.

How the larvae reached the ground was a puzzle to us at first, but we found that they dropped down of their own accord. Occasionally orange-colored larvae were found on tree trunks, but they were not crawling down, but appeared to be going upward.

Finally some black cloth screens were placed on the ground under infested cherry trees and the larvae dropped readily to the cloth. They were most active about 4 o'clock in the afternoon. Eighteen larvae dropped to cloth screens between 2.15 and 4 p. m., June 29, according to notes made by Mr. T. M. McCall.

The Cocoon and Pupa Stage. The small earthen cells of the larvae were found commonly in the summer within an inch of the surface of the soil. Probably they go deeper for the winter.

In the summer it was about 20 days after the slugs entered the soil that the adults emerged. In 19 cases the average time was 19.9 days, with a range of 15 to 23 days.

The Adult. The sawflies were most numerous early in the morning, although they were found in small numbers at other times in the day. In July the sawflies all appeared at about the same time, but in the spring the emergence was spread over a much longer time.

NATURAL ENEMIES.

Egg Parasites. The most common egg parasite was *Pentarthron minutum* Riley, kindly determined for me by Mr. A. A. Girault. It is a very tiny, yellow-brown species, which has often been reared from the eggs of a number of common insects.

At Ames this species was reared abundantly in 1909, but not at all in 1910. A few individuals were reared from eggs collected at Reinbeck, Iowa, in August, 1910.

From the first brood eggs the parasites emerged from June 28 to July 20; from the second brood eggs, from August 11 to August 20th.

The eggs affected by this parasite turn black, and of course fail to hatch. Two or three individuals were reared from a single egg.

Professor Peck in his original account mentions what is doubtless this same species and gives figures of it. After looking over the account I came to the conclusion that Peck had reared the same parasite in Massachusetts in 1798 that I reared in Iowa a hundred years later. Mr. A. A. Girault, to whom I referred a copy of this account, corroborated my opinion that Peck's parasites were most probably *Pentarthron minutum*.

The second egg parasite, *Closterocerus cinctipennis* Ashmead, also determined by Girault, was reared equally abundant in 1909 and 1910, from eggs collected at Ames. This species also affected both broods of eggs, emerging from first brood eggs June 28 to July 22, and from second brood eggs August 4 to August 21.

This parasite was always reared singly from the eggs. The black form of the parasitic pupa could often be distinguished within the parasitized eggs. It is presumably a primary parasite.

Predaceous Enemies. In 1910 nymphs and adults of *Podisus maculiventris* Say were found to be very active against the slugs. Most frequently the slugs themselves were attacked, but the Podisus also captured the adults, according to observations made by Mr. T. M. McCall.

One Podisus nymph was kept 47 days in an insectary cage, during which time it ate 66 slugs; 1.4 slugs a day. The greatest activity was immediately after the insect became an adult, when it ate 6 and 7 slugs a day.

A species of Chrysopa and an undetermined Reduviid were also observed to prey on the slugs.

Experiments with Insecticides.

Paris green, 1 pound to 150 gallons of water, was effective. A home-made arsenate of lead, single strength, was not effective. Used against the older slugs this spray was very inefficient. I could not see that any slugs at all were killed by it. When used against the very young slugs, about half of them were killed.

A 10% solution of kerosene emulsion appeared to be quite effective.

Several simple soap solutions were found effective, at concentrated strengths. Whale oil soap, 1 pound in 2 gallons of water; Ivory soap, 1 bar in 2 gallons and White Laundry soap, 1 bar in 2 gallons of water, were all satisfactory treatments. These soap solutions may be quite convenient for use on a few cherry trees when the fruit is present.

DISCUSSION.

A MEMBER: I should like to ask if it is possible to use the spraying that is applied for curculio to kill the slug, or whether the slug works so late in the season that poison applied for the curculio would be washed from the leaves.

MR. WEBSTER: The spraying should be done about the middle of June in central Iowa. I am not familiar enough with the curculio to say whether this spraying would affect it or not.

A MEMBER: It would be too late to arrest the curculio.

DR. HOWARD: I regret that I did not hear all of the paper. I should like to ask about the affect of a strong stream of water on the slugs, without any insecticide at all.

MR. WEBSTER: I did not try that.

DR. HOWARD: In city yards a strong stream of water from a hose can be used to wash off the slugs. This method has been tried and given good results.